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WIND PRESSURE ON A MODEL OF THE EMPIRE STATE BUILDING

The following is an abstract of a paper by H. L. Dryden, chief of the bureau's aerodynamic section, given before the Philosophical Society of Washington, November 5, 1932.

When the Empire State Building was constructed in New York City, provision was made through the cooperation of architects, engineers, and owners to have the building serve as a laboratory for obtaining more accurate knowledge of wind pressure. Under the direction of the committee on research of the American Institute of Steel Construction, 30 pipes were placed at the thirty-sixth, fifty-fifth, and seventy-fifth floors, transmitting the pressure from small openings in the exterior faces of the building to accessible places on each floor. In addition, some of the steel columns under the tower portion of the building on the twenty-third floor were provided with strain gauges for determining strains in the columns due to wind. Instruments for measuring the direction and velocity of the wind were mounted on the top of the building.

The forecasting of the wind pressure to be expected on a building has many of the aspects of a game of chance. It is practically certain that the speed of the wind will exceed 5 miles per hour at some time during every day of the year. In Washington, D. C., the speed will exceed 40 miles per hour about four times a year. So far as known, it has not blown at a speed of 100 miles per hour at Washington, D. C., in the 60 years or so that records are available. It is a practical impossibility to design all buildings to withstand the maximum speeds which have ever been experienced anywhere. The engineer must draw the line at some speed which is not likely to be exceeded in the life of the building. To obtain information of this kind from direct observations on a building would require years of measurements and a statistical study of the results. Moreover, the results would not necessarily be applicable to some other building of a different shape.

The only long-continued observations on the wind are those made by the Weather Bureau. These observations give the wind speeds, and to determine the pressure on the building, the relation between the pressure and the speed must be known. The method of obtaining this relation which is now coming into use is that of making measurements on models in a wind tunnel, a device in which artificial winds may be produced. Although the method of model testing is well known in hydraulics and aeronautics and has

been found invaluable, it is new to structural engineers. Full confidence has not been placed in the results, because of some feeling of uncertainty as to the application to buildings in the natural wind. When the program of the American Institute of Steel Construction to be carried out on the Empire State Building was announced, the Bureau of Standards saw an opportunity to demonstrate the utility and validity of model measurements. Owing to business conditions, the measurements on the actual building had to be postponed, but experiments have been completed on a model of the building at the Bureau of Standards. When the results on the actual building are finally available comparisons can be made.

The Empire State Building is 1,250 feet high; the model is 5 feet high. On this scale the height of a man would be a little more than one-quarter inch. The model is built of aluminum plates to the exterior shape of the building, omitting minor irregularities of the surface. It does not represent the actual building in material, method of construction, or strength. It is not tested to failure but is used only for measurements of wind pressure. Small holes in the outer walls are connected by rubber tubing to a pressure gauge. The air near the surface of the model pushes on the air in the rubber tubing with the same pressure as on the neighboring solid wall of the model. The pressure is transmitted to a gauge, where it is balanced by the weight of a column of liquid. In some tests the model was mounted in bearings and the overturning moment measured.

The artificial wind was produced in the 10-foot wind tunnel of the bureau, in which speeds up to 70 miles per hour may be obtained.

Under normal conditions, with no wind blowing, the surfaces, both interior and exterior, of all buildings are subjected to the normal atmospheric pressure of 14.7 pounds per square inch. When the wind blows this pressure is modified. In some places the pressure increases, in others it decreases by amounts which usually do not exceed a few tenths of a pound per square inch. When the pressure is reduced below the normal atmospheric pressure the effect is often called a suction. The results on the model of the Empire State Building show, as for other models tested, that the pressure varies greatly from point to point and that suction effects predominate. The greatest loads on the building occur when the wind blows directly against one face. The average pressure is of the order of 35 to 40 pounds per square foot at a wind speed of 100 miles per hour. At other wind speeds the pressure varies as the square of the speed; that is, at 50 miles per hour, it is only 9 or 10 pounds per square foot.

It was found that the speed of the air rushing by, close to the building, is greater than that of the approaching wind. Thus the instrument on the building gives a speed about 25 per cent greater than the speed of the wind approaching the building.

The detailed results, giving charts of the distribution of pressure with the wind striking the model from different directions, will be published in a few months as a Research Paper of the Bureau of Standards.

EXPOSURE TESTS OF OUTSIDE WHITE AND TINTED PAINTS

During November, 1930, 15 paints in both white and tints were exposed on the roof of the bureau's chemistry building. The exposure is still in progress, but the following report is of interest. In general, the information given in Letter Circular No. 333, "Outside House Painting," July 11, 1932, is being borne out. For tints, a lead-zinc paint meeting Federal Specification No. TT–P36 is very good. For white, the same paint or straight white lead or "45–35–20" titanox-lead-zinc are excellent. A leaded zinc-lithopone paint (recently recommended formula) was only fair. In using the "45–30–20" titanox-lead-zinc paint for tints more zinc is recommended for better color retention. One of the best combinations for tints is a paint containing in the pigment about 37 per cent barium titanox, 33 per cent white lead, and 30 per cent zinc oxide. Therefore 30 per cent zinc oxide is recommended in these titanox-lead-zinc paints, where both whites but particularly tints are to be considered.

FADING OF ORANGE PAINTS

The accelerated weathering apparatus, after being repainted, was in practically continuous operation during October. Results on both a 15-day and a 55-day test of 20 commercial samples of international orange paints have been given to the Bureau of Lighthouses. Of these 20 points, three showed particularly bad fading of color. These same 20 paints were exposed out of doors on July 15, 1932.

At the present time all the paints are in good condition, with the exception of the three that showed the worst fading in the accelerated test. These same three paints are now beginning to show fading on the outdoor tests. This paint is an orange-red, about the color of the condiment paprika. The following is a typical formula for the pigment:

	Per cent
Chrome orange	85
Zinc oxide	5
Toluidine toner	2
Magnesium silicate	8

The toluidine toner is an extremely fast-to-light dye by itself. However, when used in only a small amount (as in the above-mentioned formula) it fades rather quickly in the accelerated test. Zinc oxide is an excellent pigment in an outside house paint, as it tends to retard the fading of tints, such as cream, sky-blue, etc. In a solid color paint, such as light or medium chrome yellow, zinc oxide tends to keep the chrome yellow from darkening. However, in these dark orange-red paints the advantage of zinc oxide is questionable. Accelerated exposure tests on two experimental paints (with and without zinc oxide) indicate more "fading" with the zinc oxide.

NEW TYPES OF PAPER-TESTING EQUIPMENT

As the result of recent work at the bureau, three new instruments have been made available for testing paper—one for measuring water resistance, another for measuring the opposite quality of absorptiveness, and a third for removing coatings from paper so that the paper base can be inspected and tested.

It was found that about 40 methods are available for measuring the rate of penetration of water, writing fluids, etc., and, as might have been suspected from their multiplicity, most of them are unsatisfactory for the purpose. A simple and effective method was developed, which consists in floating the paper on water after having sprinkled on the upper surface of the paper a little powder containing some water-soluble dye. More recently a simple apparatus to facilitate the test has been devised. The paper is clamped over a hole in the bottom of an aluminum float, a watch glass and a spring clamp being used to hold it in place. The float is placed on a vessel of water so that the underside of the paper becomes wet. Before clamping the watch glass over the paper a little of the dry indicator powder is sprinkled on the upper surface by means of a shaker made of a small screw-cap vial in the end of which is fastened a disk of fine-mesh wire screen. A stop watch is used to determine the time required for the water to penetrate through and cause the color to develop in the powder.

Paper towels are required to absorb rapidly a thin film of water from the skin. In testing paper toweling for absorptive quality it is difficult to provide a film of water of known, uniform thickness which can be used to measure the relative time required by different towels to absorb a given amount of water. Since the towels are thin, only a very small volume of water can be soaked up at any one spot. Hence, if one can place very small drops of water of constant, known volume on the different towels and measure the time required for each to be absorbed the testing conditions practically duplicate the service conditions, provided the drops are so small that they are absorbed by sinking into the paper rather than by spreading sideways very much. The bureau has developed an apparatus for placing on the surface of paper accurately measured drops of water little larger than the head of a pin. The apparatus consists of a small graduated pipette mounted at an angle and provided with a needle valve so that small measured amounts of water can be valved out and touched to the surface of the paper to be tested. A stop watch is used to time the absorption period.

Federal specifications for carbon paper require the measurement of the ream weight of the tissue base on which the carbon coating is applied. It is a rather difficult matter to remove the carbon coating completely from a fairly large sheet of carbon paper. Formerly this was done, although with indifferent success, by immersing the sheet in chloroform and rubbing off the coating with pads of cotton. Obviously such a procedure would not be popular with the laboratory or stock-room personnel. An improved extractor and friction cleanser has recently been developed, which can be used to clean satisfactorily not only carbon paper but also a variety of other sheet materials, such as waxed paper, case-lining paper, sheathing paper, balloon fabric, and artificial leather in sheets nearly a foot square. The apparatus consists of a special form of reflux condenser

in which the paper is carried on a rotating cylinder and is scrubbed lightly with a brush. The combination of fresh, hot solvent and scrubbing is very effective.

ANALYSIS OF WEIGHTED SILK

Raw silk, as it comes to the manufacturer, contains about 75 per cent of fiber (fibroin) and about 25 per cent of gum (sericin), exclusive of moisture. At some stage of the processing the gum is removed by "boiling off" in a soap solution. The silk may then be "weighted" by the addition of various metallic salts or other substances, the amount of weighting being determined by the purposes for which the silk is intended, the intended selling price, and similar considerations. The amount of weighting added seldom is less than the amount of the gum removed, and it may exceed the amount of the silk fibroin. The claim is made that weighted silk has a better "hand" or "feel" than unweighted silk, that it drapes better, and that its lower cost makes possible the use of silk by persons who otherwise could not afford it.

After weighting, the silk may be dyed, or printed. It is finally "finished" by the addition of gums, soaps, waxes, hygroscopic substances, or other "finishing" materials which contribute to the desired properties.

The need for a standard method of analysis for weighted silk arose several years ago when special attention was being given to the problem of overweighting. There was an insistent demand from numerous manufacturers, distributors, and consumers for definite limits on the amount of weighting to be allowed on different types of silk fabrics. This led to the tentative designation of limits by the Silk Association of America in January, 1929. In order to insure satisfactory analyses of weighted silks for conformance with these standards or other standards that might be agreed upon, attention was given by a technical committee on weighted silk to methods of analysis. A survey of the literature resulted in a "proposed standard method" which was the one in common use calling for extraction with hydrofluoric acid, amplified to make possible the successful analysis of silks weighted with materials other than tin-phosphate-silicate. When samples of silk of known weighing content were submitted to cooperating laboratories for analysis by this method the results were in error in one instance by no less than 32 per cent of the amount actually present and in two other instances by 17 and 20 per cent.

In anticipation of the need for analyses of weighted silks in several projects in the textile section of the Bureau of Standards, and with the expectation that the Federal Trade Commission would require analyses of weighted silks in connection with its recent trade practice ruling on the labeling of silks, some attention was given to the development of a generally applicable and satisfactory method. This work resulted in a method which is reasonably rapid, convenient, and reliable.

By the method developed, weighting and finishing materials are removed by repeated extractions first with hot water, then with a 2 per cent solution of sodium carbonate and finally with a solution containing 2 per cent hydrochloric and 2 per cent hydrofluoric acids. Analyses of samples of known composition indicate that the results are correct to within 1 per cent of the weight of the dried sample. Results obtained by inexperienced analysts, working in different laboratories, have been in good agreement when samples of the same silk were analyzed.

This work and the resulting method are fully described in Research Paper No. 498 in the November issue of the Bureau of Standards Journal of Research. Qualitative methods for the identification of the following weighting materials are included in it: Aluminum, lead, phosphate, silica, tin, and zinc.

CORROSION OF KNITTING NEEDLES

Considerable trouble has been reported in the knitting of silk stockings, owing to the corrosion and pitting of individual needles in the transfer and knitting bars. The transfer bar, which consists of a series of steel needles arranged parrallel to each other and held firmly at one end between two strips of metal (usually steel, brass, or both) is used for transferring the partially completed stocking from one set of needles to another. A line of shallow pits on the needles, which are generally produced after the needles have been in service for some time, leads to a roughening of the needle, whereby the thread of the weave passing around the needle is caught and torn. Consequently, stockings of inferior grade are produced which necessitates the removal of the transfer bar and the installation of a new one.

The results of some laboratory tests carried out at the bureau indicate that this difficulty is due in large measure to "contact corrosion" between the needle and the thread which is kept wet with an oil emulsion. The emulsion examined was sufficiently corrosive to produce a slight attack on the steel at those points where the thread was in contact with the needle for several hours. Corrosive attack similar to that obtained in service could thus be reproduced in the laboratory.

The remedy for this difficulty evidently lies in the modification of the oil emulsion, whereby no corrosive action on the steel occurs, or in the use of a more resistant metal.

DETERMINATION OF LEVULOSE IN CRUDE PRODUCTS

Research Paper No. 426 in the April, 1932, number of the Bureau of Standards Journal of Research, dealt with the physical properties of levulose and means for its estimation. As a sequel to this, Research Paper No. 495, which will appear in the November number of the Journal, describes in detail the methods of analysis of crude substances which contain levulose. These methods have been devised mainly for the purpose of controlling the process of levulose manufacture from the juices of the Jerusalem-artichoke, but are equally valid for the analysis of other crude materials. Specifications are supplied for the hydrolysis of polysaccharides, clarification, analysis for total reducing sugar, and selective analysis for levulose. The methods are applied to honey and various fruits, in most of which levulose is found to be the predominating sugar.

CONCENTRATION OF THE ISOTOPE OF HYDROGEN IN WATER

Water formed by burning hydrogen from a tank of commercial electrolytic hydrogen was found to have a density greater than ordinary water by about 3 parts in 1,000,000, thus showing that this tank of electrolytic hydrogen had been produced by the electrolysis of water already considerably concentrated in the H^2 isotope. The isotopic composition of commercial tank hydrogen is, therefore, variable, depending upon the age of the electrolyte in the cells from which the hydrogen happened to come. Hydrogen produced by the electrolysis of a large quantity of ordinary water, when burned produced water of a lower density than ordinary water, the decrease in density being about 3 parts in 1,000,000. Hydrogen produced in the laboratory, therefore, by the customary processes consists almost entirely of the H^1 isotope. An experiment is now under way to prepare a considerable amount of this low-density water for the purpose of reelectrolyzing it to see whether any further decrease in density takes place.

SENSIBILITY TO COLOR-TEMPERATURE CHANGE AS A FUNCTION OF TEMPERATURE

It is possible to estimate the temperature of many incandescent substances from the color of the light which they emit. For example, it is common knowledge that the temperature of red-hot iron is lower than that of iron which gives off a more yellowish-red light. Similarly, the temperature of the yellow candle flame is lower than that of the filament of a modern incandescent lamp which gives off light of a more whitish yellow.

The color of the light emitted from a hot surface, although chiefly determined by the temperature of the surface, also depends somewhat on the character of the surface. A convenient standard of reference, which avoids the uncertainty of the surface character, is the light from a small hole in a uniformly heated inclosure. It has been proved that both the intensity and color of this light are dependent only on the temperature of the inclosure no matter what material lines the inside of the inclosure. When the light from an inclosure gives a color match with the light from a heated surface, the color temperature of the heated surface is defined as the temperature of the inclosure. The true temperature of the heated surface may differ considerably from its color temperature. In this way the relation between color and temperature may be made to form the basis of precise measurement. Thus, red-hot iron has a color temperature of about 800° on the absolute (or Kelvin) scale of temperature; a glowing cigar end has a color temperature of about 1,000° K; a candle flame yields about 1,800° K; a modern incandescent lamp gives about 2,800° K; the carbon arc, 4,000° K; and the sun, about 6,000° K.

An investigation has been made at the bureau to determine how rapidly the color changes as color temperature is varied. It has been found that the color changes with temperature more rapidly at low than at high tempera-

tures. For example, it is easily possible to tell the difference in color between two sources whose color temperatures differ by 100° near 2,000° K, but this same temperature difference at 6,000° K would ordinarily go unnoticed. A much more convenient indication of color difference is afforded by the reciprocal of the color temperature; it is suggested that reciprocal color temperature might with advantage often be used instead of color temperature.

STANDARD STEEL SAMPLES OF KNOWN NITROGEN CONTENT

As a result of an apparently increasing general interest in the determination of nitrogen in ferrous materials, the bureau has received numerous requests for iron or steel samples of known nitrogen content, for standardizing purposes. As described in Research Paper No. 494, which will be published in the November number of the Bureau of Standards Journal of Research, the nitrogen contents of four of the current standard samples have been determined, and these four samples, with nitrogen contents ranging from 0.005 to 0.028 per cent, are now available as standards for analysts interested in the determination of nitrogen.

Data are presented to show that the nitrogen contents of several standard samples of iron and steel have not changed during periods as long as 13 years. These data are offered in answer to the question that has been raised as to the permanence of the nitrogen content of these samples.

THERMAL EXPANSION OF MAGNESITE TO 1,800° C.

Among the refractory materials included in an investigation of the linear thermal expansion of special refractories from atmospheric temperature to 1,800° C. are four samples of magnesite, as follows: (1) Austrian; (2) electrically fused; and (3) two from California representing different deposits.

Expansion data were obtained for these materials on specimens 6 inches long and 1 inch in cross section after heating at two different temperatures; either 1,400° or 1,580° C., and in all cases to 1,800° C. In general, the expansions of the four magnesites are similar; although the total may vary somewhat, the rate in all cases is uniform, with a tendency to increase as the temperature increases. Heating the specimens to the different temperatures did not greatly affect their expansions, except that contraction occurred of the specimens fired to the lower temperatures close to the temperature to which they had been heated before testing.

The maximum total expansion of the Austrian magnesite after heating to 1,800° C. was 2.43 per cent. It was obtained at 1,500° C. The specimen contracted after reaching this temperature even though it had been preheated to 1,800° C. and differs from the others in that respect. The average coefficient of expansion from 20° to 1,500° C. was 16.4×10^{-6}. The petrographic examination shows the raw material to be very heterogeneous. It contains approximately 85 per cent of an isotropic material having an index of refraction ranging from 1.73 to 1.76.

The electrically fused magnesite showed a maximum total expansion of 2.45 per cent after heating to 1,800° C. It was obtained at 1,800° C. The average coefficient of expansion from 20° to 1,500° C. was 13.2×10^{-6}. The petrographic examination shows this material to be very pure. It is composed of over 90 per cent periclase and less than 1 per cent glass.

The two magnesites from California differ in their content of impurities. The one sample was furnished in brick form, and the petrographic examination indicated it to contain between 90 and 95 per cent periclase. The maximum total expansion after heating to 1,800° C. was 2.57 per cent. It was noted at 1,765° C. The average coefficient of expansion from 20° to 1,500° C. was 14.2×10^{-6} and compares with 14.7×10^{-6} obtained on the second sample furnished in bulk form. The maximum expansion, 2.35 per cent, was obtained at 1,630° C, the highest temperature reached after the specimen had been heated to 1,800° C.

REACTION OF WATER ON CALCIUM SILICATES

Any explanation of the setting of Portland cement must take into consideration reactions in the system lime-silica-water. A portion of this system at 30° C. has therefore been investigated with especial reference to the hydration and hydrolysis of calcium silicates.

The reactions of tricalcium silicate and beta-dicalcium silicate with water involve simultaneously two processes: (1) The formation of metastable and supersaturated solutions of progressively greater lime concentra-

tion and decreasing silica content; (2) precipitation of hydrated calcium silicate containing increasing proportions of lime from such solutions. Monocalcium silicate, which is nonhydraulic, gives solutions which do not show this continuous change.

Decomposition of supersaturated silica solutions prepared over a wide range of lime concentrations permitted construction of the stable solubility curve as well as determination of the compositions of precipitates in contact with the solutions at equilibrium. Application of the Freundlich adsorption isotherm showed that initially the solid phase consists of hydrated silica which reaches its maximum solubility of 0.326 gram SiO_2 per liter at a lime concentration of 0.070 gram CaO per liter. Subsequently a rapid rise in lime content of the solid phase occurs to the molar ratio $CaO/SiO_2=1:1$, and several lines of evidence point here to the formation of a definite hydrated calcium silicate. The existence of hydrated compounds of higher lime content has not been proved or disproved, although the solid phase approaches a molar composition of $2CaO:1SiO_2$ when in contact with saturated lime solutions.

It has been shown that the same equilibria can be approached in the reverse direction by the reaction of diatomaceous silica upon lime solution whereby the lime content of the former is increased at the expense of that in solution until the appropriate relation between composition of solid phase and solution is attained.

DENSITY AND REFRACTIVITY OF SOME SODA-LIME GLASSES

Reference to this subject was made in Technical News Bulletin No. 179 (March, 1932). The statement in that item referred to refractivity for yellow light. The work has been extended to include the refractivities of these glasses for the lithium red (6,707.8 A), mercury green (5,460.7 A), and mercury blue, (4,358.3 A) lines. Within the limits of accuracy of the measurements made (0.0004) the refractivities for the various wave lengths are linear functions of the squares of the frequencies. The relations may be expressed by the empirical equation:

$$N=A+K(0.4540-V)+K'C$$

in which N is the refractivity for any wave length, A is the refractivity of fused quartz for that wave length, V is the specific volume of the glass under consideration, C is the percentage of lime in that glass, $K=0.8164+2{,}780{,}000D$, and $K'=0.00128-4.27$, D being the square of the frequency for the given wave length.

It is thought the equation given above can be safely used to determine with fair accuracy the index of refraction of any of the glasses studied for any wave length between 7681.9 and 4046.6 A.

NEW AND REVISED PUBLICATIONS ISSUED DURING OCTOBER, 1932

Journal of Research[1]

Bureau of Standards Journal of Research, vol. 9, No. 4, October, 1932 (RP Nos. 482 to 492, inclusive). Price, 25 cents. Obtainable by subscription.

Research Papers[1]

(Reprints from Journal of Research)

RP461. A vacuum tube amplifier for feeble pulses; L. F. Curtiss. Price, 5 cents.

RP463. Tests of cellular sheet-steel flooring; J. M. Frankland and H. L. Whittemore. Price, 10 cents.

RP466. The reciprocal spherical aberration of an optical system including higher orders; H. F. Bennett. Price, 5 cents.

RP467. An attachment for turning approximately spherical surfaces of small curvature on a lathe; I. C. Gardner. Price, 5 cents.

RP469. Note on the freezing point of "iso-octane" (2, 2, 4-trimethylpentane); J. H. Bruun and M. M. Hicks-Bruun. Price, 5 cents.

RP470. A twin-bomb method for the accurate determination of pressure-volume-temperature data and a simple method for the acurate measurement of high pressures; E. W. Washburn. Price, 5 cents.

Circulars[1]

C399. Standard time throughout the world. (Supersedes C280.) Price, 5 cents.

Simplified Practice Recommendations[1]

R131–32. Glass containers for mayonnaise and kindred products. Price, 5 cents.

R132–32. Ice-cream cups and cup caps. Price, 5 cents.

Commercial Standards[1]

CS39–32. Wool and part-wool blankets. Price, 5 cents.

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[1] See footnote on following page.

Commercial Standards Monthly[1]

Commercial Standards Monthly, vol. 9, No. 4, October, 1932. Price, 10 cents. Obtainable by subscription.

Technical News Bulletin[1]

Technical News Bulletin No. 186, October, 1932. Price, 5 cents. Obtainable by subscription.

LETTER CIRCULARS

It is the intent of the bureau to distribute single copies of these mimeographed letter circulars on request only to those parties having a special interest in the individual letter circular. Economy necessitates limitation in the number of copies issued. It is not the intent to supply parties with a copy of each letter circular issued during the month. Letter circulars are necessarily of a temporary nature designed to answer numerous inquiries on a given subject. Requests should be addressed to the Bureau of Standards, Washington, D. C.

LC345. List of active simplified practice recommendations.

LC346. List of active simplified practice recommendations available in sheet form.

LC347. Sundials. (General information and methods of construction.)

OUTSIDE PUBLICATIONS[2]

Curtis, H. L., Sparks, C. M., Hartshorn, L., and Astbury, N. F., International intercomparison of the capacitance and power factor of a mica condenser, Collected Researches of the National Physical Laboratory (Teddington, England), vol. 24, p. 57, 1932.

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Denison, I. A., Estimating the corrosiveness of acid soils, Oil and Gas Journal (Tulsa, Okla.), vol. 31, p. 83, September 29, 1932.

Shepard, E. R., Measurement of electrical conductance of pipe coatings, Oil and Gas Journal (Tulsa, Okla.), vol. 31, p. 100, September 29, 1932.

Ingberg, S. H., Fire protection of valuable records, Safety Engineering (Stroudsburg, Pa.), vol. 63, No. 6, p. 273, June, 1932, and vol. 63, No. 7, p. 23, July, 1932.

Castleman, R. A., jr., The mechanism of atomization of accompanying solid injection, National Advisory Committee for Aeronautics (Washington, D. C.), Technical Report No. 440. Obtainable from the Superintendent of Documents at 5 cents per copy.

Kiess, C. C., Spectrographic observations of the chromosphere and corona, Publications of the United States Naval Observatory (Washington, D. C.), Second Series, vol. 13, Appendices II, III, and IV, p. 91, 1932.

Gardner, I. C., Spherical surfaces of slight curvature, American Machinist (New York, N. Y.), vol. 76, p. 994, 1932.

Coblentz, W. W., The transmissive properties of tinted lenses, American Journal of Ophthalmology (American Medical Association, Chicago, Ill.), vol. 15, No. 10, p. 932, October, 1932.

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Coblentz, W. W., The Copenhagen meeting of the Second International Congress on Light, Science (Grand Central Terminal, New York, N. Y.), vol. 76, No. 1975, p. 412, November 4, 1932.

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Fowler, R. M., The determination of silicon in steels, Industrial and Engineering Chemistry, analytical edition (Washington, D. C.), vol. 4, p. 382, 1932.

Lofton, R. E., A measuring microscope for rubber specimens, Industrial and Engineering Chemistry, analytical edition (Washington, D. C.), vol. 4, p. 439, October 15, 1932.

Rasch, R. H., and Stone, G. O., Estimating stability of paper by heating, Paper Trade Journal (New York, N. Y.), July 28, 1932.

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[1] Send orders for publications under this heading only to the Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 50 cents per year (United States and its possessions, Canada, Cuba, Mexico, Newfoundland, and Republic of Panama); other countries, 70 cents. Subscription to Journal of Research, $2.50 per year; other countries, $3.25. Subscription to Commercial Standards Monthly, $1; other countries, $1.60.

[2] "Outside publications" are not for distribution or sale by the Government, unless otherwise noted. Requests should be sent direct to publishers.

Scribner, B. W., and Snyder, L. W., A study of physical properties of binders board, Paper Trade Journal (New York, N. Y.), October 20, 1932.

Carson, F. T., and Worthington, F. V., New types of equipment for testing paper, Paper Trade Journal (New York, N. Y.), October 20, 1932.

Walkup, H. H., and Groesbeck, E. C., Some factors affecting the Preece test for zinc coatings, Metal Industry (London, England), vol. 41, pp. 177 and 201, August 19 and 26, 1932.

Gardner, H. B., and Saeger, C. M., jr., Factors affecting the properties of red brass, Metal Industry (London, England), vol. 41, pp. 181 and 199, August 19 and 26, 1932.

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Palmer, L. A., and Parsons, D. A., Rate of stiffening of mortars on a porous base, Rock Products (Chicago, Ill.), September 10, 1932.

Boutell, Hugh G., Notes on total eclipse of the sun at Kennebunk, Me., August 31, 1932, Popular Astronomy (Northfield, Minn.), vol. 40, No. 8, p. 484, October, 1932.

The following articles were published in the United States Daily (Washington, D. C.):

H. D. Hubbard:

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